US006513802B2

(12) **United States Patent**
Seger

(10) **Patent No.: US 6,513,802 B2**
(45) **Date of Patent: Feb. 4, 2003**

(54) **QUICK CHANGE TOOLING SYSTEM FOR A VACUUM HOLDING FIXTURE FOR A THERMOFORMED PART**

(75) Inventor: **Anthony C. Seger**, Sidney, OH (US)

(73) Assignee: **Tooling Technology LLC**, Huber Heights, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 139 days.

(21) Appl. No.: **09/801,316**

(22) Filed: **Mar. 7, 2001**

(65) **Prior Publication Data**

US 2002/0124695 A1 Sep. 12, 2002

(51) **Int. Cl.**[7] **B25B 11/00**
(52) **U.S. Cl.** **269/21**; 82/160; 269/20; 269/266; 269/309
(58) **Field of Search** 269/21, 266, 309, 269/43; 279/121, 122, 50, 57; 294/86.4, 96, 64.1

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,185,814	A	*	1/1980	Buchmann	271/108
4,773,839	A	*	9/1988	Case	425/186
5,322,719	A	*	6/1994	Westling	428/34.1
5,660,380	A	*	8/1997	Reis	269/21
5,722,646	A	*	3/1998	Soderberg	269/20
5,899,445	A	*	5/1999	Kimble	269/21

* cited by examiner

Primary Examiner—Joseph J. Hail, III
Assistant Examiner—Daniel Shanley
(74) *Attorney, Agent, or Firm*—Jacox, Meckstroth & Jenkins

(57) **ABSTRACT**

A vacuum holding fixture for a thermoformed part carries a base attachment plate which is releasably coupled to the top wall of a vacuum support box having a vacuum passage sealed to a vacuum passage within the attachment plate and a vacuum chamber within the holding fixture. The attachment plate is precisely positioned and releasably locked to the vacuum box by a plurality of couplers each including a stud projecting downwardly from the attachment plate and received within a corresponding cylinder recessed within the vacuum box. Each cylinder has locking balls which releasably grip the corresponding stud in response to axial movement of a fluid actuated spring biased piston surrounding the cylinder.

11 Claims, 2 Drawing Sheets

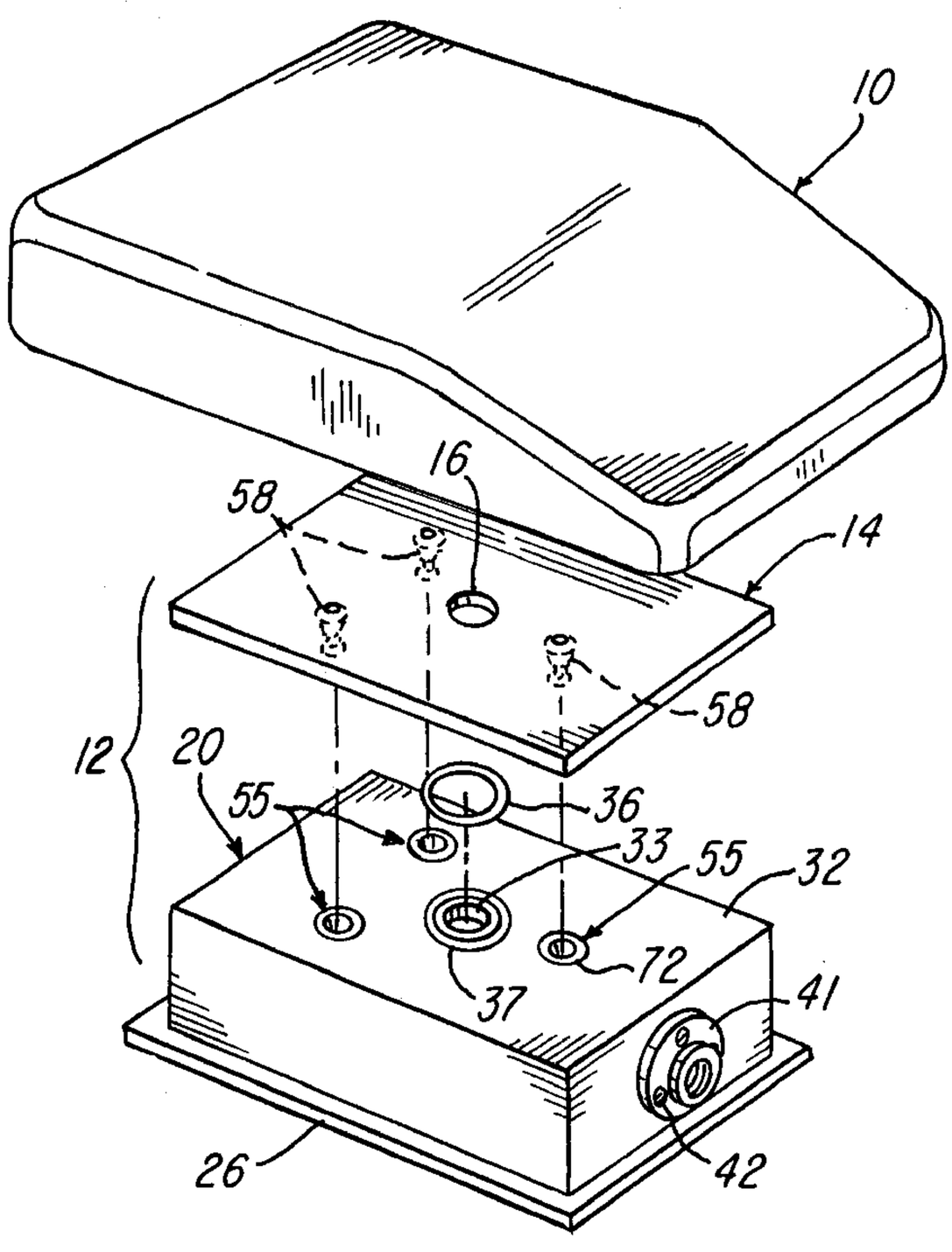


FIG-1

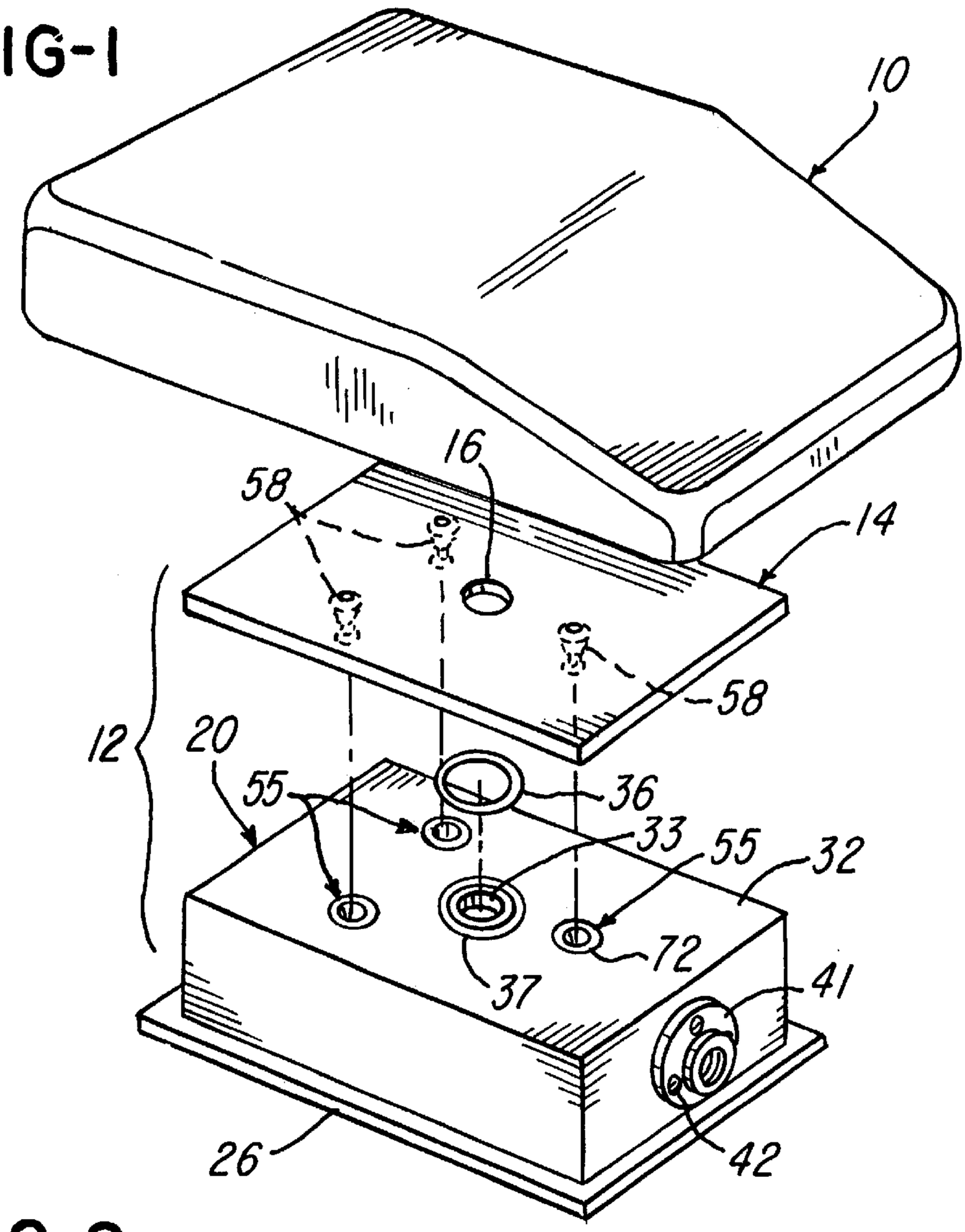

10
16
58
14
58
12
20
55
36
33
55
32
72
37
41
26
42

FIG-2

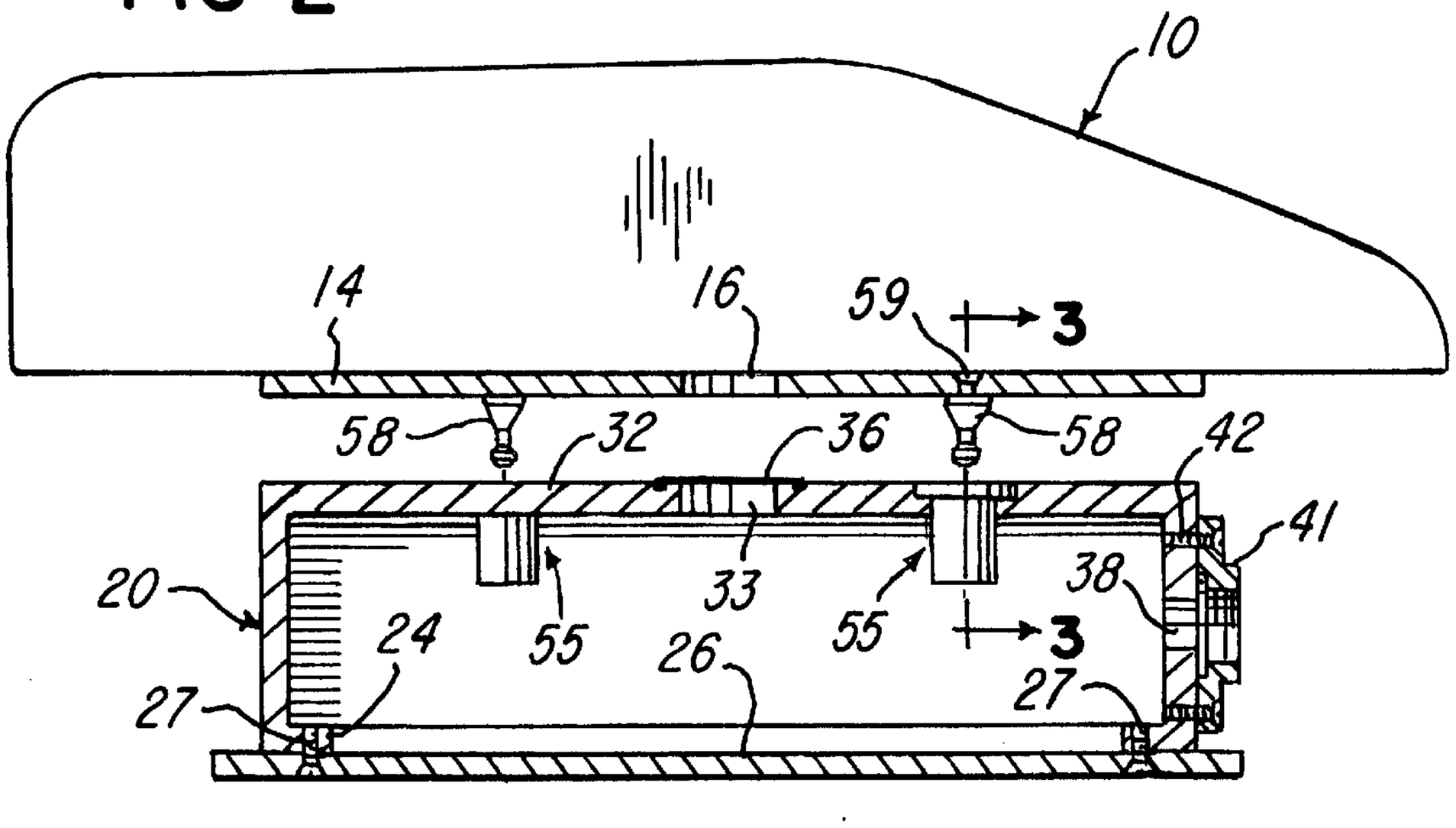

10
14
16
59
3
58
32
36
58
42
41
20
24
55
33
55
38
3
26
27
27

FIG-3

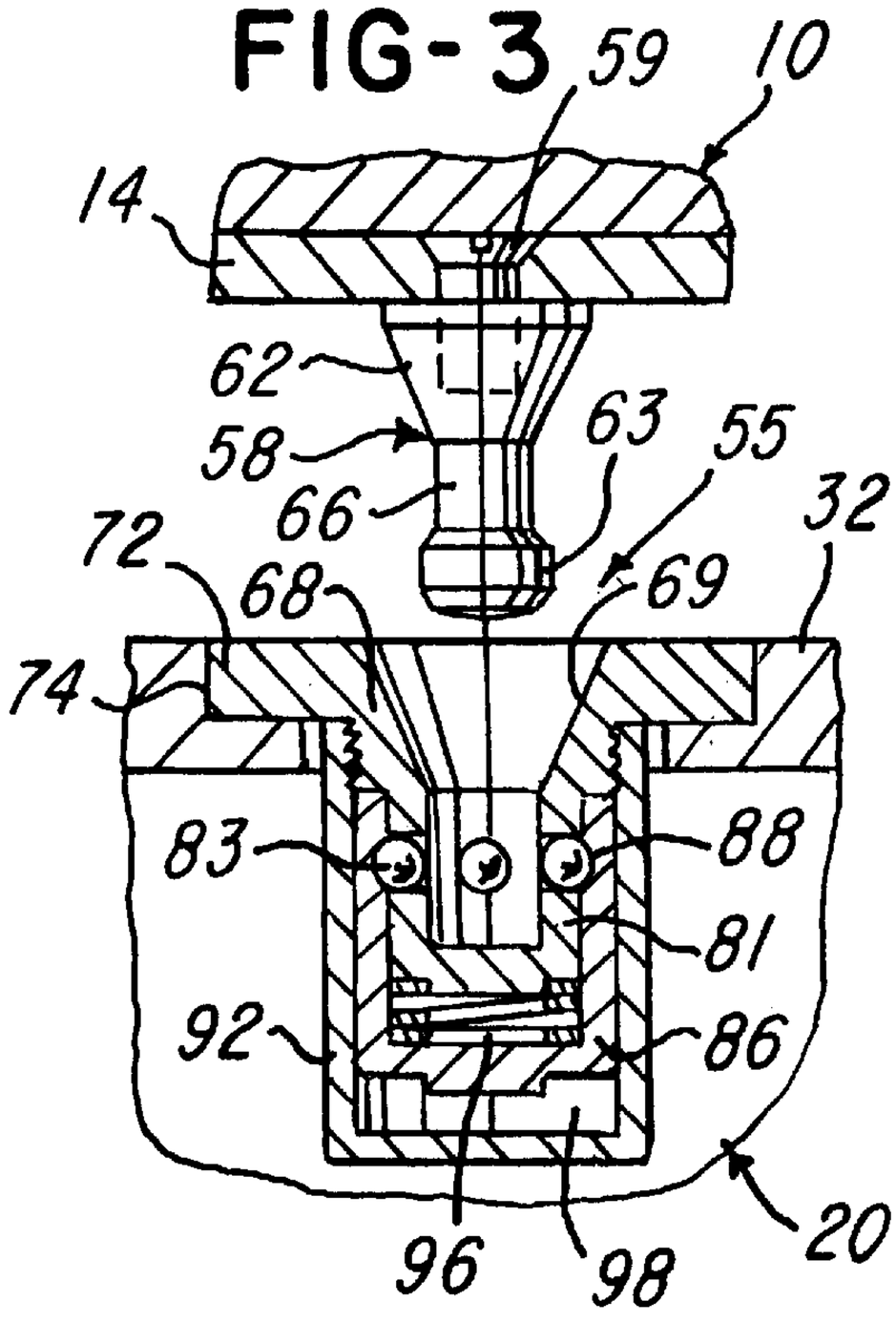
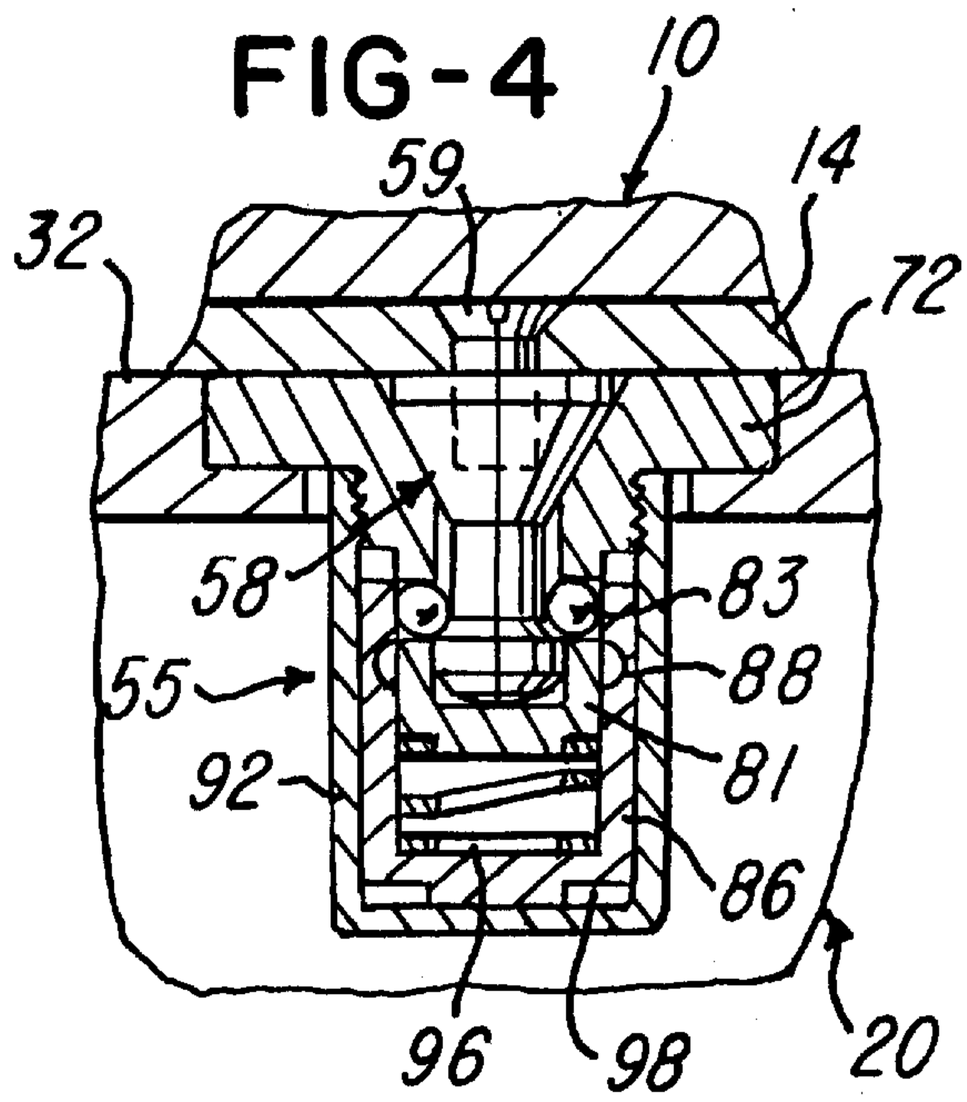

59
10
14
62
58
63
55
66
32
72
68
69
74
83
88
81
92
86
96
98
20

FIG-4


10
59
14
32
72
58
83
55
88
81
92
86
96
98
20

QUICK CHANGE TOOLING SYSTEM FOR A VACUUM HOLDING FIXTURE FOR A THERMOFORMED PART

BACKGROUND OF THE INVENTION

In the production of custom thermoformed articles or parts, such as parts produced by blow molding, vacuum molding, rotomolding, compression molding, resin transfer molding and reaction injection molding, it is usually necessary to perform one or more secondary operations on each part after it is formed. For example, the part may require peripheral trimming on a computer numerically controlled (CNC) router machine having a high speed router which is automatically moved around the base of the part to trim off an outwardly projecting flange. Commonly, each part is supported during the secondary trimming operation by a corresponding vacuum router fixture which receives the part and has small vacuum passages extending from an internal vacuum chamber within the fixture for positively holding the part firmly against the fixture. Each router fixture must be precisely positioned on the bed or table of the CNC router machine and then attached with clamps and/or bolts, after which the fixture is connected to a vacuum or suction line. These set up operations for the router fixture for each part require substantial time, and when it is necessary to perform trimming on a number of different thermoformed parts, several hours may be required for interchanging router fixtures and for precisely locating and positively securing or clamping each fixture to the router table. During this time period, the router machine is not operating, and the operator of the machine is not producing.

SUMMARY OF THE INVENTION

The present invention is directed to an improved quick change tooling system for a vacuum holding fixture which receives a thermoformed part in order to perform a secondary operation on the part, such as a peripheral trimming operation. The tooling system of the invention provides for quickly removing a vacuum holding fixture for a part from a machine which performs a secondary operation on the part and for quickly attaching another vacuum holding fixture for another part to the machine. As a result, down time of the machine and nonproductive time of the machine operator are minimized during set up for each fixture. The quick change tooling system of the invention further provides for quickly positioning each vacuum holding fixture on the machine and for positively locking the fixture to the base of the machine in a precise predetermined position, thus eliminating the use of hand tools, bolts, clamps and other fastening means. The tooling system also provides for quickly removing the vacuum holding fixture from the machine.

In accordance with one embodiment of the invention, an attachment plate is secured to the bottom surface of a vacuum holding fixture for a thermoformed part and has an opening which connects with a vacuum chamber within the fixture. The fixture is provided with an array of small vacuum passages connecting the internal vacuum chamber with the outer surfaces of the fixture. The attachment plate is adapted to seat on the top wall of a vacuum box which is connected by a line to a vacuum source. A resilient annular seal is mounted on the top wall of the vacuum box around a vacuum opening and forms an airtight seal between the vacuum opening in the attachment plate and the aligned vacuum opening within the top wall of the vacuum box.

A plurality or three air actuated locking couplers positively secure the fixture attachment plate to the vacuum box

and precisely locate the vacuum fixture relative to the vacuum box which is secured to the bed or table of a machine. Preferably, each of the locking couplers includes a knob or stud projecting downwardly from the attachment plate and having an enlarged head portion which is received within a locking cylinder recessed within the top wall of the vacuum box. Each locking cylinder has circumferentially spaced balls for engaging the head portion of the corresponding coupler stud, and a spring loaded piston surrounds the balls and normally holds the balls in a locking position. The balls of all couplers retract to released positions in response to pressurized air simultaneously acting on the pistons of the couplers.

Other features and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of a quick change tooling system constructed in accordance with the invention for precisely positioning and positively and releasably locking a vacuum holding fixture for a thermoformed part to a supporting vacuum box;

FIG. **2** is a section taken through the attachment plate and vacuum holding box shown in FIG. **1** and showing the alignment between the attachment plate and the vacuum box in a released position with the vacuum holding fixture elevated above the vacuum box;

FIG. **3** is a fragmentary section taken generally on the line **3**—**3** of FIG. **2** and showing a locking coupler in its released position with the vacuum holding fixture elevated above the supporting vacuum box; and

FIG. **4** is a fragmentary section similar to FIG. **3** and showing a coupler when the tooling system is in its coupled and locked position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** illustrates a vacuum holding fixture **10** for a thermoformed part (not shown) and which typically supports the part on the base or table of a CNC router machine. The fixture **10** conforms to the shape of the part which extends over the top wall and around the opposite side walls and opposite end walls of the fixture. Commonly, the part has a laterally outwardly projecting peripheral base flange which is removed or trimmed by a numerically controlled router machine having a router bit which traverses around the periphery of the part while the part is supported by the vacuum holding fixture **10**. Usually, the fixture **10** is cast of aluminum and defines an internal vacuum chamber (not shown) which is connected by small holes or passages to the outer surfaces of the fixture. When vacuum is introduced into the chamber of the fixture **10**, the part is held firmly against the outer surfaces of the fixture.

In accordance with the present invention, a quick change tooling system **12** includes an attachment plate **14** which is secured to the bottom surface of the vacuum holding fixture **10** by a series of bolts or screws (not shown) and defines a center vacuum opening or port **16** which connects with the vacuum chamber within the fixture. However, it is understood that the configuration of the vacuum holding fixture **10** is for purpose of illustration only and that the quick change tooling system of the invention may be used with other vacuum holding fixtures of different configurations. As illustrated in FIG. **2**, the attachment plate **14** is adapted for

mounting and seating on a vacuum box **20** which is shown in the form of a cast aluminum housing **22** having an inwardly projecting base flange **24** secured and sealed to a base closure plate **26** by peripherally spaced screws **27**.

The housing **22** has a top supporting wall **32** which has a center vacuum opening **33** positioned to be aligned with the vacuum opening **16** within the attachment plate **14**. A resilient O-ring **36** is recessed within an annular groove **37** within the top wall **32** of the vacuum box **20** and surrounds the vacuum **35** opening **33** to form a fluid-tight seal between vacuum box and the attachment plate **14**. An end wall of the vacuum box **20** has a vacuum port or opening **38** and receives a pipe coupling flange **41** which is secured by a set of screws **42**.

The flange **41** threadably connects with a vacuum pipe or line which extends from a vacuum source (not shown).

The attachment plate **14** and the fixture **10** are releasably coupled and locked to the vacuum box **20** by a plurality of locking couplers **55** preferably of the type manufactured and sold by Edward D. Segen & Co., LLC of Shelton, Conn. and referred to in its catalog as a "Quick-Change Cylinder Lock".

Each of the three couplings **55** includes a male portion in the form of a metal knob or stud **58** which is secured by a screw **59** (FIG. **3**) to the attachment plate **14** and projects downwardly from the attachment plate. Each knob **58** has a tapered or frusto-conical base portion **62** integrally connected to a head portion **63** by a neck portion **66** of reduced diameter.

Each of the couplings **55** also includes a female portion in the form of a cup-shaped cylinder **68** (FIG. **3**) having a tapered internal surface **69** which mates with the tapered surface **62** of the stud **58**. The cylinder **68** also has an outwardly projecting annular flange **72** which is received within a corresponding counterbore **74** within the top wall **32** of the vacuum box **20** and which is secured by peripherally spaced screws (not shown). Each of the coupler cylinders **68** also has an integral cup-shaped cylindrical portion **81** which defines a cavity for receiving the head portion **63** of the corresponding stud **58**, and a plurality of hardened steel locking balls **83** are retained within corresponding circumferentially spaced holes within the cylinder portion **81** for corresponding radial movement.

A cup-shaped piston **86** surrounds the portion **81** of the cylinder **68** and has a circumferentially extending internal groove or cavity **88** (FIG. **3**) for receiving the balls **83** in their retracted positions when the piston **86** is in its released position (FIG. **3**). A cylindrical cup-shaped housing **92** surrounds the piston **86** and has an upper end portion threadably connected to the cylinder **68**. The housing **92** confines and supports the piston **86** for axial movement between an upper released position (FIG. **3**) with the balls **83** retracted and a lower locked position (FIG. **4**) when the balls **83** are cammed radially inwardly to engage the head portion **63** and neck portion **66** of the stud **58**. A flat wire compression spring **96** normally urges the piston **86** downwardly to the locked position of the coupler **55** (FIG. **4**). When it is desired to release each stud **58** from its cylinder **68**, pressurized fluid or air is introduced into a chamber **98** defined below the piston **86** and within the housing **92** to force the piston upwardly against the bias of the spring to the released position (FIG. **3**). In this position, the balls **83** move radially outwardly into the cavity or groove **88**, allowing the stud **58** to be lifted and removed from its cylinder **68**.

In operation of the quick change tooling system **12**, the vacuum source to the vacuum box **20** is shut off, and pressurized air is simultaneously supplied to the chambers **98** of the locking couplers **55** so that the pistons **86** move upwardly allowing the locking balls **83** to shift to retracted and released positions, as shown in FIG. **3**. The vacuum holding fixture **10** with its attachment plate **14** may then be lifted from the vacuum box **20** and replaced by another vacuum holding fixture with its corresponding attachment plate **14**. After the next vacuum holding fixture and its attachment plate **14** are seated on the top wall **32** of the vacuum box **20**, the air pressure within the chambers **98** of the couplers **55** is released or exhausted, and the compression springs **96** move the pistons **86** downwardly to cam the balls **83** inwardly to their locking positions, as shown in FIG. **4**. When it is desired to replace one holding fixture with another holding fixture, the above steps for removing one fixture and replacing it with another fixture are repeated.

From the drawings and the above description, it is apparent that a quick change tooling system constructed in accordance with the invention, provides desirable features and advantages. For example, the tooling system provides for accurately and quickly positioning a vacuum holding fixture **10** on the bed or table of a CNC router and for positively and quickly locking the fixture to the bed or table. As a result, a change of fixtures or other tooling may be performed in only a few minutes so that down time of the router machine and the unproductive time of the machine operator are minimized. The quick change tooling system of the invention also eliminates the need for hand tools, bolts, clamps, shims and other such devices which are commonly used for precisely aligning and securing a router fixture on the table of a router machine. Moreover, as soon as the attachment plate **14** on the bottom of a fixture is seated on the top wall of the vacuum box **20**, a vacuum may be introduced into the vacuum box **20** and the vacuum holding fixture **10** simply by opening a valve in the vacuum line.

While the form of quick change tooling system or apparatus herein described constitute a preferred embodiment of the invention, it is to be understood that invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope and spirit of the invention as defined in the appended claims.

What is claimed is:

1. A quick change tooling system adapted for use with a vacuum holding fixture for a thermoformed part, said system comprising an attachment plate having a vacuum opening and adapted to be secured to the bottom of the vacuum holding fixture, a vacuum box having a top wall for receiving and supporting said attachment plate and the vacuum holding fixture, said top wall of said vacuum box having an opening connected to said vacuum opening within said attachment plate, said vacuum box having a connection to a vacuum source, and a plurality of spaced releasable locking couplers securing said attachment plate to said top wall of said vacuum box.

2. A tooling system as defined in claim **1** wherein said opening in said top wall of said vacuum box aligns with said vacuum opening within said attachment plate, and a resilient sealing ring surrounding said openings and forming a vacuum seal between said vacuum box and said attachment plate.

3. A tooling system as defined in claim **2** wherein said top wall of said vacuum box has an annular groove surrounding said vacuum opening in said top wall, and said sealing ring is disposed within said groove.

4. A tooling system as defined in claim **1** wherein each of said locking couplers comprises a stud mounted on said attachment plate and having an enlarged head portion pro-

jecting downwardly from said plate, and a locking cylinder mounted on said top wall of said vacuum box and having a set of radially movable balls releasably engaging said head portion of said stud.

5. A tooling system as defined in claim **1** and including at least three of said locking couplers securing said attachment plate to said top wall of said vacuum box.

6. A tooling system as defined in claim **1** wherein each of said locking couplers comprises a cylinder having holes supporting a plurality of circumferentially spaced balls for corresponding radial movement, a downwardly projecting stud on said attachment plate and having an enlarged head portion, a piston supported around said cylinder and having a recess for receiving said balls in a released position, a spring urging said piston to a locked position with said balls engaging said head portion of said stud, and a housing supporting said piston and cooperating to receive fluid pressure for moving said piston to a released position with said balls received within said recess.

7. A quick change tooling system in combination with a vacuum holding fixture for a thermoformed part, said system comprising an attachment plate having a vacuum opening and secured to the bottom of the vacuum holding fixture, a vacuum box having a top wall receiving and supporting said attachment plate and said vacuum holding fixture, said top wall of said vacuum box having an opening connected to said vacuum opening within said attachment plate, said vacuum box having a connection to a vacuum source, a resilient seal surrounding said openings and forming a vacuum seal between said vacuum box and said attachment plate, and a plurality of spaced releasable locking couplers securing said attachment plate to said top wall of said vacuum box.

8. A tooling system as defined in claim **7** wherein said top wall of said vacuum box has an annular groove surrounding said vacuum opening in said top wall, and said seal comprises a sealing ring disposed within said groove.

9. A tooling system as defined in claim **7** wherein each of said locking couplers comprises a stud mounted on said attachment plate and having an enlarged head portion projecting downwardly from said plate, and a locking cylinder mounted on said top wall of said vacuum box and having a set of radially movable balls releasably engaging said head portion of said stud.

10. A tooling system as defined in claim **7** and including at least three of said locking couplers securing said attachment plate to said top wall of said vacuum box.

11. A tooling system as defined in claim **7** wherein each of said locking couplers comprises a cylinder having holes supporting a plurality of circumferentially spaced balls for corresponding radial movement, a downwardly projecting stud on said attachment plate and having an enlarged head portion, a piston supported around said cylinder and having a recess for receiving said balls in a released position, a spring urging said piston to a locked position with said balls engaging said head portion of said stud, and a housing supporting said piston and cooperating to receive fluid pressure for moving said piston to a released position with said balls received within said recess.

* * * * *